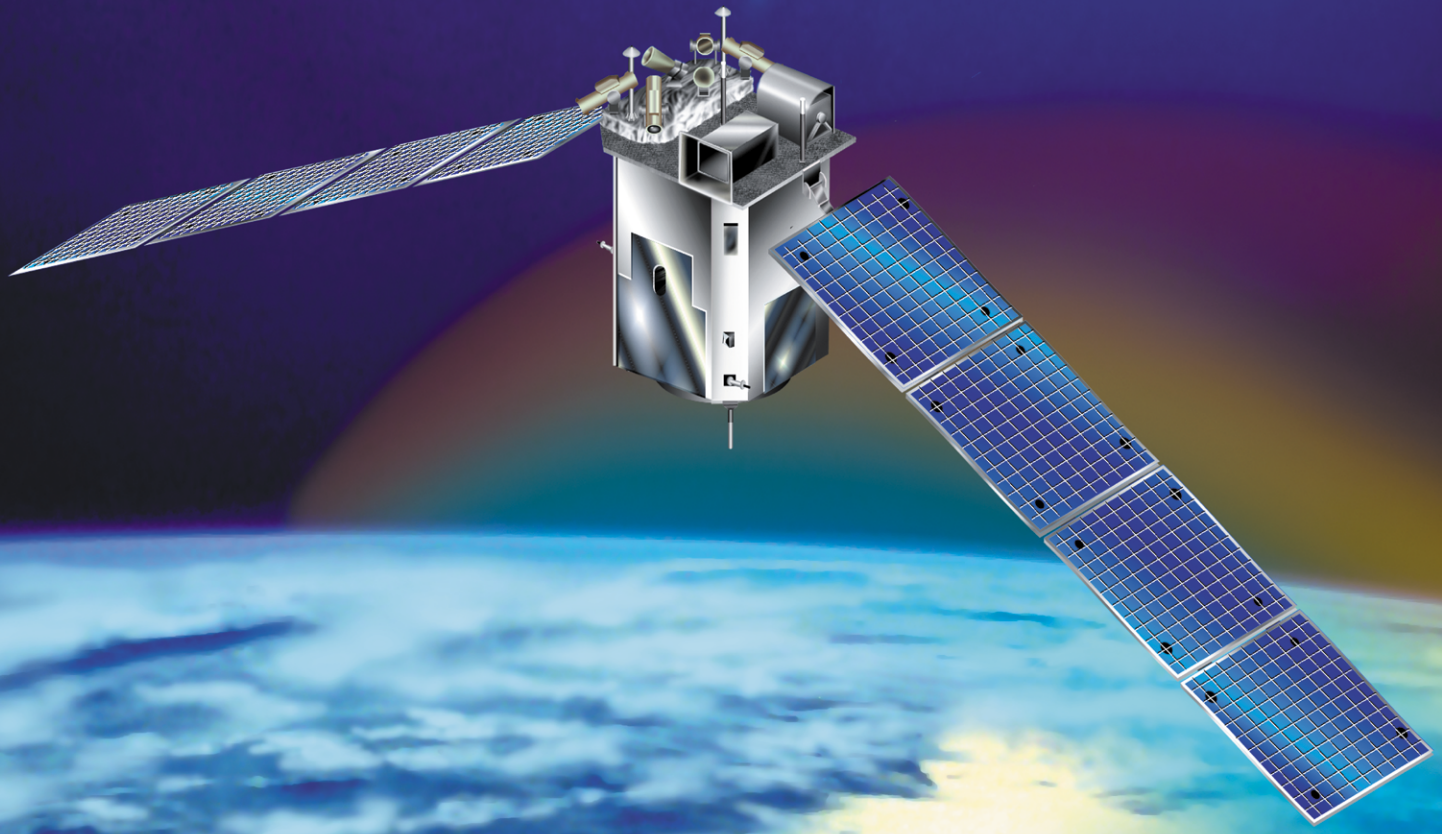
TIMED



The First NASA Solar Terrestrial Probe

A Mission to Study the Structure and Energy Balance of the Earth's Upper Atmosphere

http://stp.gsfc.nasa.gov
http://www.timed.jhuapl.edu/home.htm

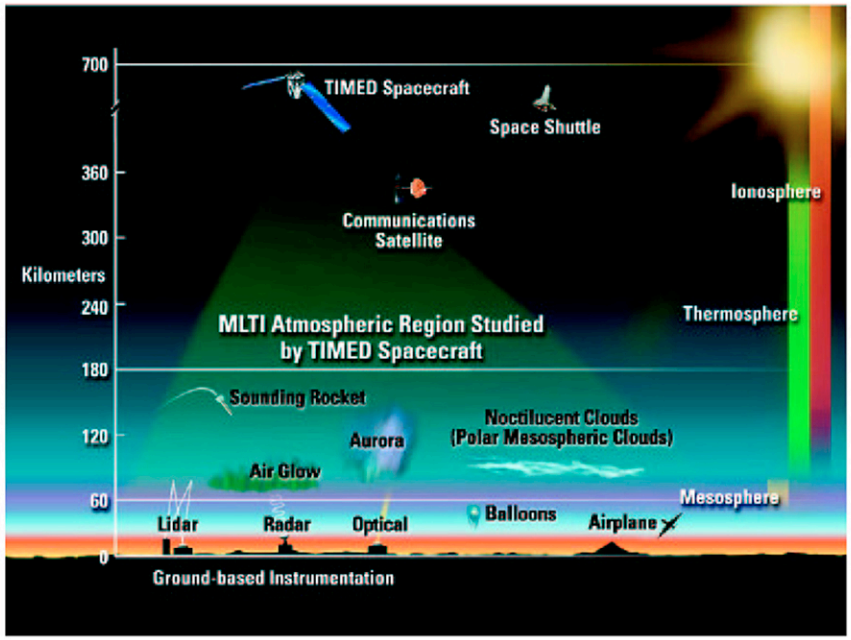
The Thermosphere • Ionosphere • Mesosphere • Energetics and Dynamics (TIMED) Mission

Why TIMED?

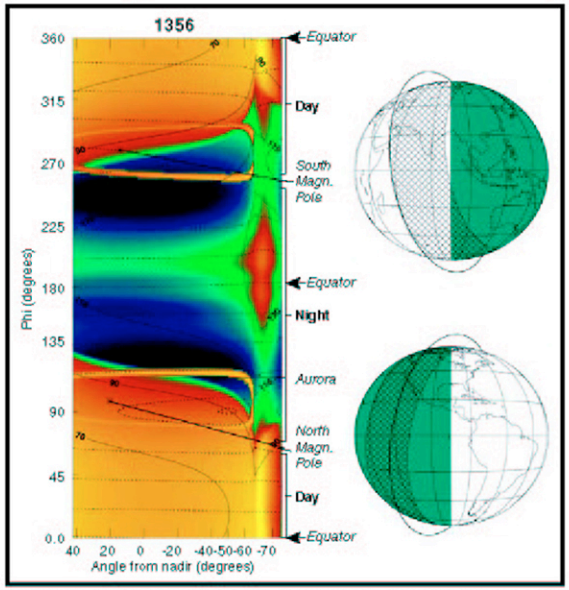
The 2-year TIMED mission will focus on the portion of Earth's atmosphere located between 40–110 miles (60–180 kilometers) above the surface – the Mesosphere and Lower Thermosphere/Ionosphere, or MLTI, a region where solar X-ray and far- and extreme-ultraviolet radiation (the most variable part of the solar spectrum) is absorbed.

TIMED will examine the entire region as a whole: its basic structure and thermal balance, how the mesosphere is coupled to the thermosphere/ionosphere, how the MLTI region is coupled to space and the lower atmosphere below, and how energy is transported from one altitude or latitude to another. TIMED will gain a better understanding of the dynamics of this gateway region and its effects upon communications, satellites and spacecraft reentering Earth's atmosphere.

A comprehensive global study of the MLTI region has never been accomplished for several reasons. This atmospheric region is too high for balloons to reach, and ground-based instruments can only see a small part of the upper atmosphere located over an observation site. Rockets flown into the region can only provide local snapshots of its activity. Without TIMED, scientists will not be able to obtain a global picture of the MLTI atmospheric region that they need to better understand the upper atmosphere and its interaction with regions above and below.



The TIMED spacecraft will observe this region and its basic structure from the spacecraft's 388-mile (625-kilometer) circular orbit around Earth. With technological advances in remote sensing, TIMED will observe this relatively unexplored frontier from space obtaining an unprecedented set of comprehensive global measurements of the MLTI region's temperature, pressure, wind and chemical composition, along with its energy inputs and outputs.



TIMED will:

- Determine the temperature, density and wind structure in the MLTI region including seasonal and latitudinal variations.
- Determine the importance of various radiative, chemical, electrodynamic and dynamic sources and sinks of energy for the MLTI, leading to an improved understanding of the energy balance within this key region.
- Provide a better understanding of interactions between the Sun and the Earth's atmosphere and their impact on human activities in space, including:
  - impacts on satellite communications due to changing character of the Ionosphere; and,
  - satellite tracking problems due to changes in the composition and magnitude of atmospheric drag, which is caused by the solar cycle, solar flares and tidal effects.
- Better determine the magnitude and character of human-induced effects on the lower thermosphere, ionosphere and mesosphere.

TIMED's measurements will be important for understanding the basic processes involved in the energy distribution of this region and the impact of natural and human-induced changes. In a society increasingly dependent upon satellite technology and communications, it is vital to understand atmospheric variability, so its effects on satellite tracking, spacecraft lifetimes, degradation of materials and reentry of piloted vehicles can be predicted. The mesosphere may also show evidence of human-influenced effects that could herald global-scale environmental changes.

Scientific Instruments:

TIMED's payload consists of four instruments.

- **Global Ultraviolet (UV) Imager (GUVI)** – A spatial scanning, far-ultraviolet spectrograph designed to globally measure the composition and temperature profiles of the MLTI region, as well as its auroral energy inputs.

  The GUVI instrument is a collaborative effort between The Johns Hopkins University Applied Physics Laboratory (JHU/APL) in Laurel, Maryland and The Aerospace Corporation in El Segundo, California.

- **Sounding of the Atmosphere using Broadband Emission Radiometry (SABER)** – A multichannel radiometer designed to measure heat emitted by the atmosphere over a broad altitude and spectral range. SABER will also measure global temperature profiles and sources of atmospheric cooling, such as the "air glow," which occurs when energy is radiated back into space.

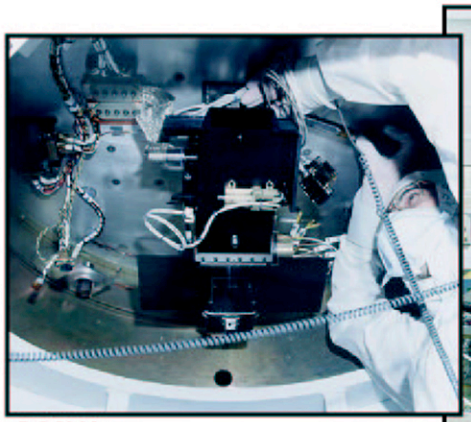
  Hampton University (Hampton, Virgina) is leading the SABER science team. Utah State University (Logan, Utah) built the instrument for NASA's Langley Research Center.

- **TIMED Doppler Interferometer (TIDI)** – An instrument that will globally measure the wind and temperature profiles of the MLTI region.

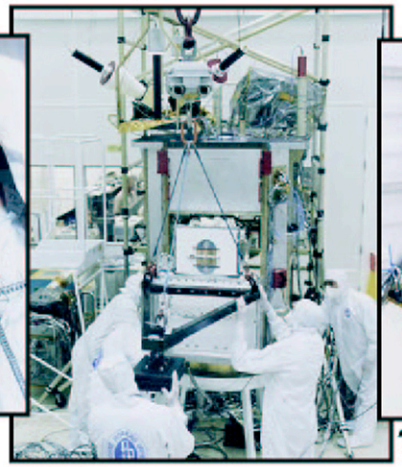
  The University of Michigan, Ann Arbor, built the TIDI instrument and is leading its science team.

- **Solar Extreme Ultraviolet Experiment (SEE)** – A suite of photometers and a spectrometer designed to measure solar ultraviolet radiation—the primary enrergy deposited into the MLTI atomospheric region—which includes solar soft X-rays and extreme-ultraviolet and far-ultraviolet radiation.

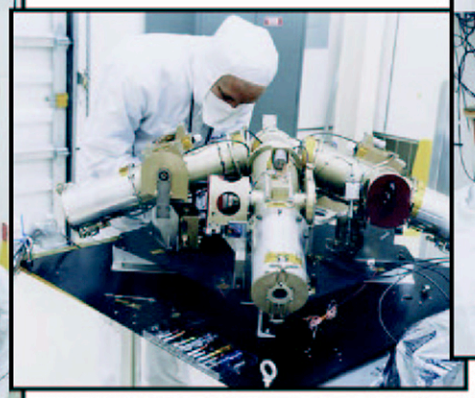
  The University of Colorado, Boulder, built the SEE instrument and is leading its science team.



GUVI



SABER



TIDI (telescope assembly)

SEE

Science Team:

Mission Science Management

- NASA HQ Program Scientist: Mary Mellott
- JHU/APL Project Scientist: Jeng-Hwa (Sam) Yee
- NASA GSFC Project Scientist: Richard Goldberg

National Science Foundation Program Management

- Aeronomy Program Manager: Sunanda Basu
- Upper Atmosphere Facilities Manager: Robert Robinson

Instrument Principal Investigators

- Andrew Christensen - GUVI (The Aerospace Corporation)
- James Russell III - SABER (Hampton University)
- Tim Killeen - TIDI (National Center for Atmospheric Research)
- Tom Woods - SEE (University of Colorado)

Interdisciplinary Investigators

- Jeffrey Forbes (University of Colorado)
- David Fritts (Colorado Research Associates/ Northwest Research Associates)
- Janet Kozyra (University of Michigan)
- Hans Mayr (NASA Goddard Space Flight Center)
- Anne Smith (National Center for Atmospheric Research)
- Stanley Solomon (National Center for Atmospheric Research)

Why is this Science Important to Us?

The Sun's energy can have profound effects on Earth's upper atmospheric regions, particularly during the peak of the Sun's 11-year solar cycle when the greatest amounts of its energy are being released. TIMED is focused on understanding and characterizing exactly how the Sun interacts with the Earth's environment. TIMED will be the first mission to conduct a comprehensive global study of the MLTI region, and will allow scientists to establish the first-ever baseline against which future studies of changes within this region can be compared and analyzed.

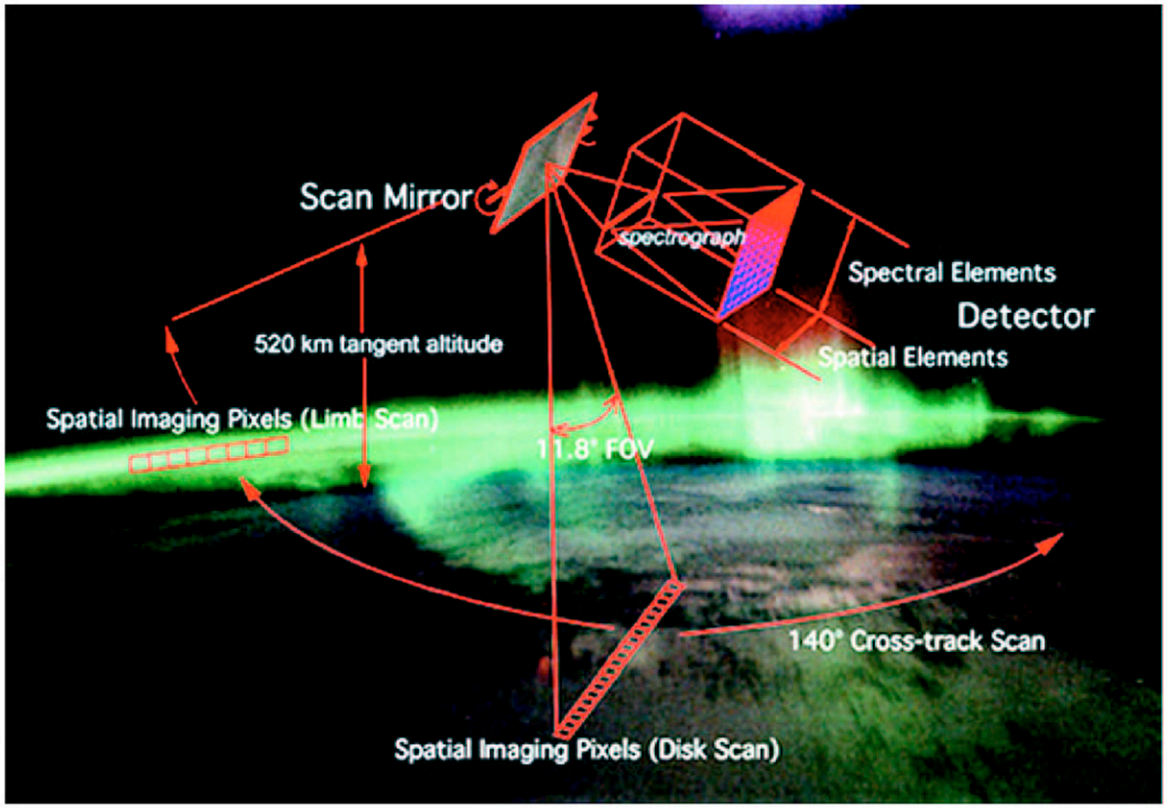
How Does TIMED Fit into NASA's Solar Terrestrial Probes Program and the Sun-Earth Connection Theme?

The Sun-Earth Connection (SEC) theme was created by NASA Headquarters' Office of Space Science as part of their Strategic Plan. The Solar Terrestrial Probes (STP) series of missions is a critical element under this theme. These scientific missions will obtain information to respond to the two quests or goals of the strategic science and technology roadmap for the SEC theme:

1. How and why does the Sun vary?
2. How do the Earth and planets respond?

The coordinated sequence of projects within the STP Program responds to these quests by focusing on the study of the Sun and Earth as an integrated system.The missions use a creative blend of in-situ and remote-sensing observations, often from multiple platforms, to understand the causes and effects of solar variability over vast spatial scales where effects refer to planetary and heliospheric responses.

The STP Program seeks to substantially reduce project cost and improve performance by using new technology. It enhances public awareness of and appreciation for space science by incorporating educational and public outreach activities as integral parts of space science investigations.



Scanning imaging technique used by GUVI.

The TIMED spacecraft is the initial launch in NASA's STP Program. The TIMED mission is sponsored by NASA's Office of Space Science in Washington, D.C., and managed by the NASA Goddard Space Flight Center's Solar Terrestrial Probes Program Office, Greenbelt, Maryland. The Johns Hopkins University Applied Physics Laboratory (JHU/APL), in Laurel, Maryland, designed, built and operates the spacecraft, leads the project's science effort and manages the mission's Science Data Center for NASA.

The TIMED Spacecraft

The TIMED spacecraft is a product of the Solar Terrestrial Probes (STP) Program at NASA's Goddard Space Flight Center (GSFC). The observatory was built at The Johns Hopkins University Applied Physics Laboratory (JHU/APL) for the STP Program.

Spacecraft Characteristics

Mission

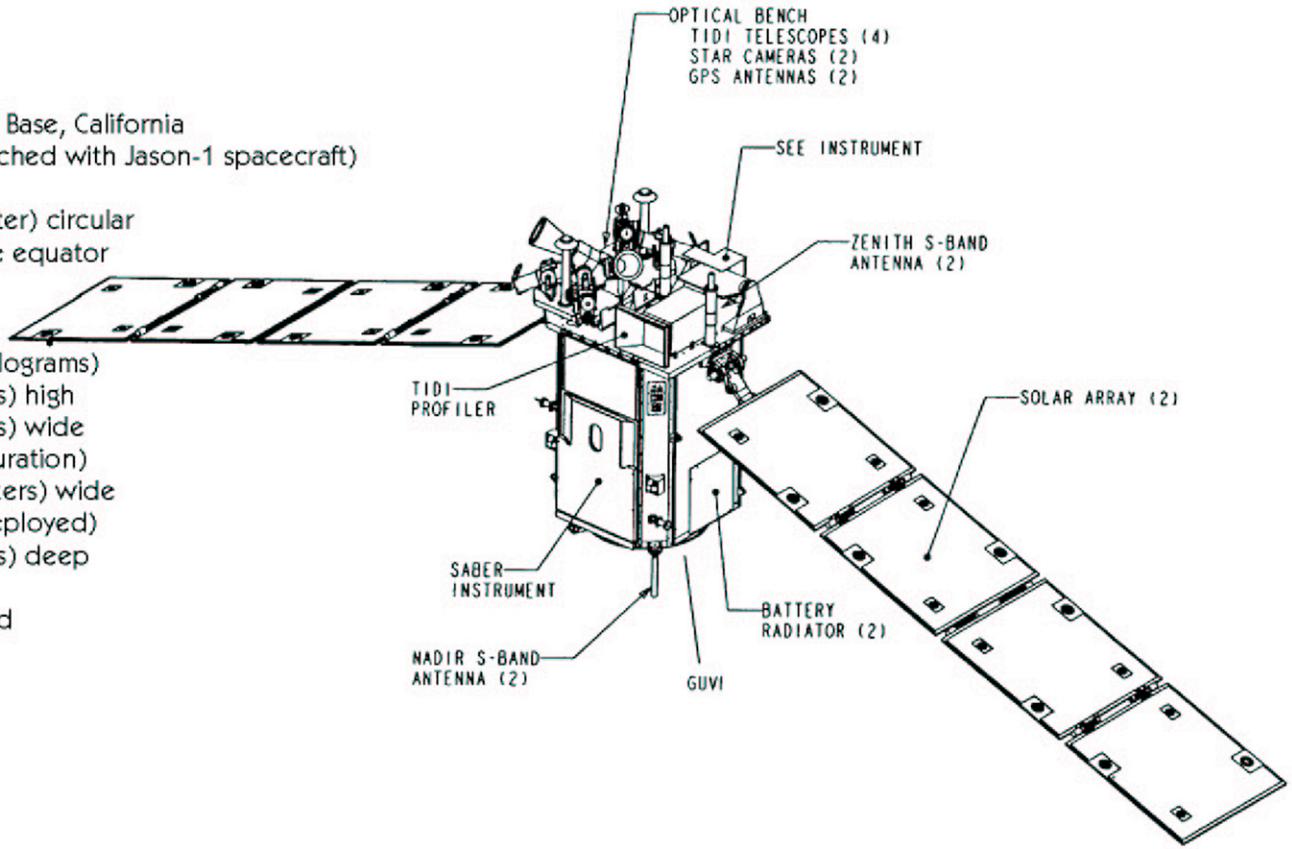
Launch	December 7, 2001
Launch Site	Vandenberg Air Force Base, California
Launch Vehicle	Delta II 7920-10 (launched with Jason-1 spacecraft)
Primary Mission	Two years
Orbit	388-mile (625-kilometer) circular
Inclination	74.1 degrees from the equator

Spacecraft

Mass	1,294 pounds (587 kilograms)
Dimensions	8.93 feet (2.72 meters) high 5.29 feet (1.61 meters) wide (launch configuration) 38.47 feet (11.73 meters) wide (solar arrays deployed) 3.93 feet (1.20 meters) deep
Power Consumption	406 watts per orbit
Data Downlink	4 megabits per second
Memory	5 gigabits
Attitude	
Control	Within 0.5 degrees
Knowledge	Within 0.03 degrees

TIMED Mission Management

- NASA HQ Program Executive: Victoria Elsbernd
- NASA GSFC STP Program Manager: Gilberto Colón
- NASA GSFC TIMED Project Manager: Bruce Campbell
- JHU/APL Project Manager: David Grant



The TIMED Launch

TIMED was launched on December 7, 2001, aboard a Delta II launch vehicle with the Jason-1 spacecraft from Vandenberg Air Force Base, Califfironia. The 1,294-pound (587-kilogram) TIMED spacecraft was placed into a 388-mile (625-kilometer) circular orbit around the Earth (inclined 74.1 degrees from the equator).

The Delta II 7920-10, used to launch the TIMED spacecraft, is a medium-lift, two-stage, liquid-propellant rocket built by the Boeing Company.

TIMED is expected to be in orbit and operate for a minimum of two years. The Mission Operations and Mission Data centers, located at The Johns Hopkins University Applied Physics Laboratory (JHU/APL), in Laurel, Maryland, will support data analysis for an additional two years after the conclusion of the mission.

Further information can be found on the Solar Terrestrial Probes (STP) Program or The Johns Hopkins University Applied Physics Laboratory (JHU/APL) Web sites at:

http://stp.gsfc.nasa.gov

http://www.timed.jhuapl.edu

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